Control of Heat Loss Associated with Overhead Doors

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Foreword

Since 1976, numerous projects have been initiated in Alberta by industry and by academic research institutions which are aimed at better utilization of Alberta's energy resources.

These research, development and demonstration efforts were funded by the Alberta/Canada Energy Resources Research Fund (A/CERRF), which was established as a result of the 1974 agreement on oil prices between the federal government and the producing provinces.

Responsibility for applying and administering the fund rests with the A/CERRF Committee, made up of senior Alberta and federal government officials.

A/CERRF program priorities have focused on coal, energy conservation and renewable energy and conventional energy resources. Administration for the program is provided by staff within the Scientific and Engineering Services and Research Division of Alberta Energy.

In order to make research results available to industry and others who can use the information, highlights of studies are reported in a series of technology transfer booklets. For more information about other publications in the series, please refer to page six.

Control of Heat Loss Associated with Overhead Doors

In Canada, approximately 380 000 buildings such as warehouses, service stations and vehicle storage depots are equipped with overhead doors to allow frequent movement of vehicles in and out, at any time of the day regardless of weather.

During the winter months, unit heaters, usually suspended from the ceiling, are used to maintain the indoor temperature of these buildings at a fairly comfortable level. In the process, however, considerable heat losses commonly occur, which contribute to high fuel costs.

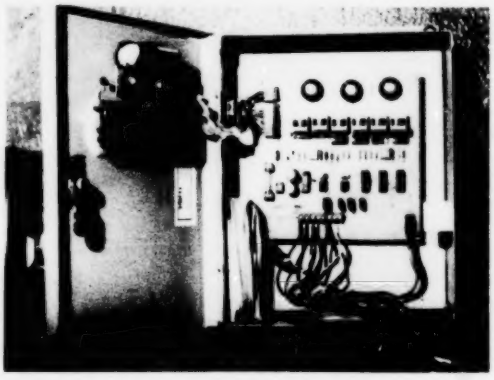
One cause of high fuel bills is the practice of allowing the heating system to operate continuously when overhead doors remain open for extended periods of time. This is done to maintain a desired comfort level for people working inside the building. A second cause of heat loss is attributed to the poor sealing characteristics of overhead doors.

Consequently, any techniques that reduce heat loss due to these openings in the building envelope would be expected to save energy. Given the fact that 21 000 buildings in Alberta can be classified as warehouse-type structures, the potential for energy savings in this application was regarded as worthy of A/CERRF-funded investigations.

A Heat-Conserving Control System for Warehouses

When overhead doors are opened, it is inevitable that some of the warm air already inside the building or produced by the unit heater will be forced out the open door by the unit heater's fan. But when the doors are left open, the thermostat setting, based on the comfort requirements of workers, usually causes the heating system to switch on. This means the heaters consume large amounts of energy to compensate for the influx of cold air.

One way to achieve lower fuel consumption without sacrificing worker comfort involves the use of a Conserve Heat Sentry device, which is used in place of a conventional thermostat. It interconnects the door mechanisms and the heating system to prevent the unit heaters from turning on as long as the doors are open. Only after the doors are closed will the unit heaters be activated.



Close-up detail of a Conserve Heat Sentry controller

Ten Heat Sentry units were installed in six warehouse locations in Calgary to determine their ability to reduce fuel consumption. They were placed in warehouses ranging in area from 2 000 to 12 000 square feet. Natural gas consumption records for one year prior to installation of the devices were compared with fuel consumption during a one-year monitoring period following installation. The comparison was made on the basis of energy efficiency, which was defined as degree days divided by natural gas consumption expressed in gigajoules.

Interior of a Master Tune outlet in Calgary, showing an overhead door and a ceiling-mounted heater. Conserve Heat Sentry controller is the small box mounted on the wall (left)

For some types of warehouses, use of the device resulted in improvements in energy efficiency of as much as 50 per cent and payback periods of less than two years. In other cases, especially buildings with many doors, which are often open, there was no improvement. This suggests marketing efforts should be directed at specific types of building configurations.

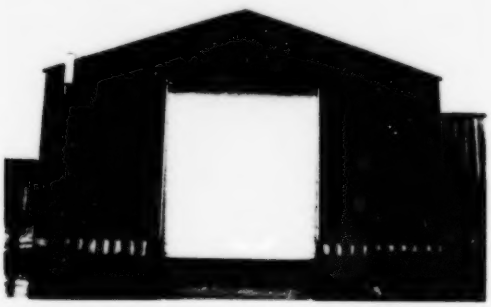
During the project, several modifications were made to the microprocessor-based device to incorporate or improve upon its energy-saving features. It comprises two programmable thermostats, one to control room temperature at normal settings of approximately 20°C while the second thermostat has setback features to achieve a lower, energy-saving temperature which may be chosen for periods when the building is unoccupied. By connecting the Heat Sentry to a seven-day timer, warehouse temperature can be alternated between occupied and unoccupied settings.

The Heat Sentry is also able to take advantage of the phenomenon whereby the air temperature in a building tends to vary with height above floor level. For example, if the ceiling is six metres high and the zone within two metres of the floor is controlled at 20°C, the region from 2.0 to 3.5 metres may be 5°C warmer while from 3.5 metres to the ceiling the temperature could be 15°C warmer. By operating the ceiling-mounted unit heater fans without turning on the burners, Heat Sentry causes warmer air near the ceiling to be driven toward the floor, thereby making optimal use of the available heat already present in the building.

Retrofit Curtain for Overhead Doors

Even when an overhead door is closed, cold air can enter or warm air can escape around the edges of the door, in a manner not easily corrected by weatherstripping. One way to circumvent the limitations of weatherstripping is to retrofit the exterior of an overhead door with an insulating curtain, a concept which was demonstrated in a project undertaken by Appropriate Technology of Calgary.

After several prototype curtains were designed and built, full-scale models were installed on both doors of a City of Calgary warehouse.



One of two retrofit curtains used on the overhead doors of a City of Calgary warehouse.

One of the essential features of insulating curtains is their ability to prevent air leakage around the top, bottom and side edges. For this particular design, a special curtain edge track system was fabricated to seal the side edges as the curtain was raised and lowered. In order to raise the curtain, a roller system was tried at first. While it worked, it was found to be somewhat complex. Ultimately, it was decided the curtain could be attached directly to the top of the door. Here, a strip of foam tubing, that compressed against the door frame whenever the door was closed, served as a seal.

At the bottom, a "bubble sealing" system was used which uses weatherstripping configured in such a manner that the curtain bottom conforms to irregularities in the surface of the door threshold.

An ultraviolet-resistant polyester material used in some outdoor awnings was chosen as the fabric for the curtain. Not only is the material durable, flexible and tear-resistant, it also transmits solar radiation. This latter property is especially important when doors are fitted with glass, because the fabric will allow sunlight to pass through.

Air leakage tests were performed on the warehouse using the fan depressurization method to measure the effectiveness of the insulating curtain in reducing air leaks. These measurements were compared with air leakage rates when (1) the doors were weatherstripped (2) the doors were not weatherstripped, and (3) the door openings were sealed with polyethylene sheeting. It was found that the insulating curtain provided a more effective seal than polyethylene and it reduced total leakage by 89 per cent (at 50 Pascals pressure difference), when compared with weatherstripped doors.

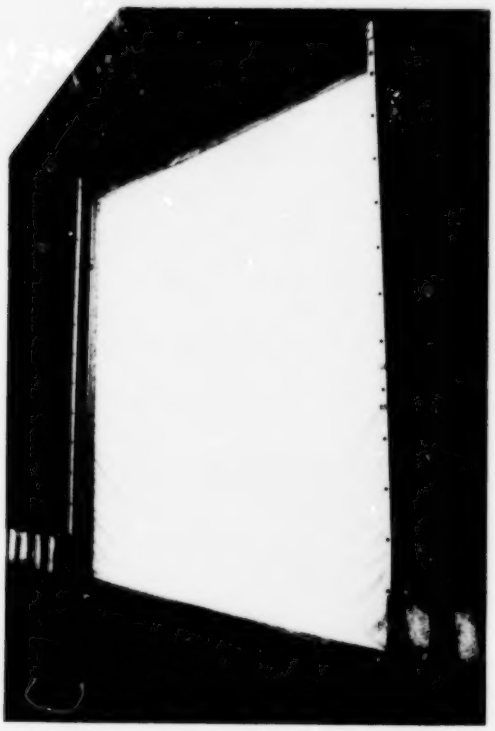
A thermal performance analysis was made of the warehouse using a 16-channel, microcomputer-based data acquisition system, which measured and recorded indoor and outdoor temperatures at several locations as well as solar radiation incident on the roof. The rate of natural gas consumption by the warehouse unit heaters was also measured.

Natural gas usage, expressed as the "Q Value," or gas consumption per degree Celsius, declined when the insulating curtains were in place on both doors. At night, the Q Value was reduced by 12 per cent; during the day, it declined by 60 per cent. The dramatic improvement during daylight hours was found to be due to a solar heating effect which was a by-product of using the retrofit curtains.

Two mechanisms were responsible for the solar heating effect. It was learned that conductive heat losses through the door were eliminated when the temperature of the outer surface of the door was greater than the indoor air temperature. Also, the curtain transformed the door into a type of solar collector. As solar radiation was transmitted through the curtain material it was absorbed by the dark-coloured door. This warmed the air in the space between the curtain and door, initiating convection processes that supplied warm air to the warehouse.

Even though the doors of this particular warehouse faced east and west, their outside temperature reached 40 to 45°C on sunny days in March and April. Had they faced south, it was estimated enough heat would be produced to satisfy the day-time heating requirements of the warehouse on sunny days, when the outside air temperature was -5 to -10°C.

The two curtains used in this project cost $956 to produce. Their use resulted in a 25 per cent reduction in gas consumption, or a cost saving of about $323 per year. This amounts to a payback period of three years.



The retrofit curtain design includes (1) a foam seal at the top (2) a T-edge track mechanism along the sides, and (3) a "bubble sealing" weatherstrip across the bottom

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